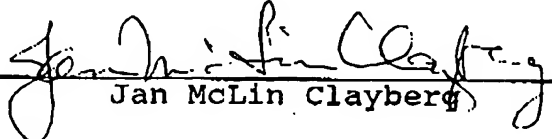June 19, 2006

<u>DECLARATION</u>

The undersigned, Jan McLin Clayberg, having an office at 5316 Little Falls Road, Arlington, VA 22207-1522, hereby states that she is well acquainted with both the English and German languages and that the attached is a true translation to the best of her knowledge and ability of the International Patent Application PCT/EP 2004/011385 of KLEINFELD, J., entitled "KEY-OPERATED MEMORY-PROGRAMMABLE CONTROL COUPLED TO A PERSONAL COMPUTER".

The undersigned further declares that the above statement is true; and further, that this statement was made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or document or any patent resulting therefrom.

Jan McLin Clayberg

KEY-OPERATED MEMORY-PROGRAMMABLE CONTROL COUPLED TO A
PERSONAL COMPUTER

5   The invention relates to a memory-programmable control (SPS) for coupling to
a data interface of a personal computer (PC), having means for operating the
inputs and outputs of the SPS, the means including keys for tripping machine
functions.

      A memory-programmable control of this kind is already known from
10   International Patent Application WO 97/03390.

      In automation technology, manifold tasks in the industrial and private field are
administered by using memory-programmable controls (SPS). The most important
function elements of the known SPSs are a program memory and an SPS user
15   logic (controller) with inputs and outputs. The SPS user logic includes a
microprocessor as well as a data memory with memory regions, in particular for
times, counters, flags, and process images. In the typical course of work, the SPS
user logic, at the beginning of each cycle, calls up the signal states at the inputs of
the SPS and sets a memory location (SPS flag), assigned to each input, to zero or
20   one. In a subsequent program execution, the microprocessor accesses the
process image of the inputs that is stored in memory and as a function of it
processes the control instructions that are in the program memory. Via the outputs
of the SPS, finally, signals are sent to the systems and machines that are to be
controlled.
25

      Besides the purely automatic mode of the SPS, however, again and again
there is a need, for instance in manual operation, to trip certain machine functions
using external user control means. Conventionally, the manual tripping of machine
functions is done via a pushbutton matrix that is located on a machine control
30   board of the SPS.

      In this conventional SPS without a PC coupled to it, which is not an SPS of the
generic type in question here, each pushbutton of the pushbutton matrix is
connected to its own input of the SPS. Via the SPS user logic, these inputs are

linked with outputs to the machine to be operated. In this way, actuating the pushbutton trips a machine function, such as the moving of a shaft. Safety requirements can readily be met, since the machine function is only active as long as the pushbutton is actuated. The signal loss of a "stop signal" for ending the

5   machine function is precluded from the very outset in this connection, since the SPS flag corresponds directly to the voltage signal at the input. A disadvantage of this described conventional tripping by external pushbuttons connected directly to an associated SPS input, each pushbutton being allocated a single fixed meaning, is that both one pushbutton and one SPS input are needed for each machine

10 function. As a result, the hardware is expensive, and the system is complicated to operate.

From the aforementioned WO 97/03390, it is known for an SPS to be coupled in a generic way to a conventional PC via a data interface, in order to be able to

15 program and operate the SPS from the customary user surface of the PC, such as its keyboard and screen. As a result, machine functions can be tripped without additional external pushbuttons, but indirectly, with the interposition of the PC, via the keys of a conventional PC keyboard.

20 In conventional user surfaces such as PC keyboards, it is furthermore widely known, for instance by using a keyboard controller, to set up three different key levels, or in other words to make keys available on the PC keyboard whose meaning changes with the particular key level selected. From there, based on the known coupling of an SPS to a PC, the possibility arises of allocating a changing

25 meaning for machine functions to at least some of the keys of the PC keyboard, and thus in terms of manual operation of a relatively large number of machine functions by an SPS to achieve economy in terms of hardware and make user operation simpler. In fact, however, with such provisions major safety concerns are involved, since when a PC key is pressed, what is forwarded to the SPS via

30 the data interface is not a direct voltage signal but rather only data that represent the image of the key status, and this leads to the occupation of a memory unit in the SPS, or in other words the setting of an SPS flag, corresponding to the key status represented. The SPS user logic links this SPS flag without outputs to the machine. Any disruption within the communications path from the PC to the SPS

would therefore undo what is only a data connection between the key and the machine function. In the event of a disruption, the most recent key status in the SPS would stay active. In the "key ON" state, the change of state to "key OFF" could not be transmitted to the SPS; that is, a machine that has been set in motion for instance would continue to move onward in an unwanted way.

It is the object of the invention, while preserving sufficient security against signal losses, to make an SPS available that has keys of changing meaning for tripping machine functions.

According to the invention, this object is attained by a memory-programmable control (SPS) as defined by claim 1. Advantageous refinements of the invention are disclosed in dependent claims 2 through 10.

The memory-programmable control of the invention is distinguished specifically first in that the keys are embodied as pushbuttons provided in addition to the conventional user surface of the PC and are each electrically connected directly to one of the SPS inputs. Moreover, from the conventional user surface of the PC, one of a plurality of key levels can be selected, each with fixed meanings, stored in memory in the PC, for the pushbuttons. In order to functionally combine the separate elements of "pb signal" and "meaning" that are constituted by these provisions, a data-processing control unit connected to the SPS inputs is provided in the SPS; from the PC via the data interface, it receives the information about the key allocation of the pushbuttons in the particular key level selected and links this information with a pushbutton signal applied to an SPS input.

The SPS of the invention with the PC coupled to it and with additional pushbuttons connected directly to the SPS inputs in this way makes it possible to economize on hardware by providing only a relatively small number of additional pushbuttons, which but they can be given meanings that can change. However, according to the invention, keys with a changing meaning are created in which at the same time, by the provision of a direct connection between the pushbuttons and the associated SPS inputs, signal losses on tripping machine functions are guaranteed to be precluded.

Especially preferred embodiments are those in which the pushbuttons are each connected, parallel to the SPS inputs, to an internal bus of the PC, so that by means of one pushbutton each, surface functions of the PC that are stored in
5   memory in the PC and are simultaneously assigned to machine functions and to the key allocation can be tripped. The parallelism in tripping machine functions and surface functions thus extends not only to the possibility of simultaneous tripping but also to the same kind of tripping by way of a key type.

10   These embodiments can advantageously be implemented by providing that in the PC, a data-processing first control unit, connected to the pushbuttons via the internal bus, is provided, which links the information about the surface functions assigned to the pushbuttons and links it with a pushbutton signal, applied to the internal bus, to make a starting signal for the surface functions assigned to that
15   pushbutton.

In a further advantageous embodiment, in the PC, a data-processing second control unit is provided, which is connected to a screen of the PC and which receives the information about a key label corresponding to the key allocation, so
20   that the key allocation of the particular key level selected can be displayed on the screen of the PC by means of a key label.

It is advantageous if the second PC control unit receives status information about the pushbuttons from the SPS control unit via the data interface; and that
25   the visual display of the key label of the individual pushbuttons can be designed to be dependent on the status information about the individual pushbuttons.

In a variant, the pushbuttons are located in the vicinity of the screen of the PC in such a way that the user of the device can establish a direct relationship with
30   the key label and/or with pushbutton status information on the screen.

In all the variants with key labeling by way of the screen, it is advantageous if the software in the PC is embodied such that the key label can be displayed in reserved areas of the screen that cannot become covered by other display

functions. Moreover, all the variants with key labeling can be implemented without requiring the aforementioned embodiments that involve parallel tripping of machine functions and surface functions.

5   Other embodiments are distinguished in that in the PC, a central memory unit is provided, in which for each selectable key level one data matrix is stored, in which matrix each of the pushbuttons is assigned a data line containing information that is allocated in columns to different purposes. The data matrix offers advantages in terms of the internal organization of intrinsically conventional

10   operating means of the PC, which here however are used in collaboration with the SPS and the pushbuttons that have changing meanings.

One exemplary embodiment of the invention will be described in further detail below in conjunction with the drawings. Shown are:

15

Fig. 1, a block circuit diagram for illustrating the cooperation of the components of the SPS and of the coupled PC in one embodiment of the invention;

20   Fig. 2, a schematic illustration of essential parts of the user surface of an SPS of the invention;

Fig. 3, a symbolic illustration of a central memory unit in the PC, with the data matrix stored there and defined for a specific selectable key level.

25

Fig. 1 shows a block circuit diagram; the basic hardware arrangement according to the invention will first be described below.

In the lower block shown in Fig. 1, components are shown, in particular a

30   control unit for flag assignment 4 and an SPS user logic 7, of the controller of an SPS; the flag assignment 4 is connected to the PC shown in the upper block via a data and communications interface 8. Also shown are keys, embodied as pushbuttons T1 through Tn, which are connected primarily directly to the inputs 9 of the SPS. The outputs 10 of the SPS, as indicated, are connected to a machine

11 that is to be controlled by the SPS. The PC with its screen 12 and a conventional keyboard 13 serves as a man-machine interface and implements user control and display functions (such as editors and position displays), hereinafter called surface functions 5. The user logic 7 of the SPS communicates

5   with the control unit for flag assignment 4 and links inputs 9 to the outputs 10 and thus trips functions of the machine 11, such as a function that enables the advancement of a drive mechanism.

It is essential that the control unit for flag assignment 4, which processes the

10   additional data, be implemented in the SPS. This flag assignment 4 is connected on the one hand directly to the SPS inputs 9 and thus to the external pushbuttons T1 through Tn, and on the other hand, via the data interface 8, it has access to information about the fixed meaning, stored in memory in the PC, of the pushbuttons T1 through Tn. The SPS user logic 7 accesses the SPS inputs 9 only

15   indirectly, via the flag assignment 4, and the flag assignment 4 contributes the key level-dependent meaning of a key signal, present in the form of a voltage signal to an SPS input 9, which meaning is variable via the PC. If the user has selected a key level, for instance via the keyboard 13, then the key allocation, or in other words the meaning of the individual keys in the key level selected, is forwarded

20   from the PC to the flag assignment 4 via the data interface 8. Thus in the SPS user logic 7, an SPS flag for a certain machine function is set (and then processed further there) whenever the information (for all n pushbuttons) corresponding to the selected key level forwarded from the PC to the flag assignment 4 matches a pushbutton signal actually applied to a certain SPS input 9. As a result of this

25   combination, the variability of the meaning of the keys on the one hand is assured, while simultaneously, signal losses of the pushbuttons T1 through Tn, which would be objectionable for safety reasons, are precluded. The flag assignment 4 can readily be implemented by software in the operating program of the SPS.

30   In the embodiment of the invention shown in Fig. 1, the pushbuttons T1 through Tn are connected to the ISA bus 14 of the PC and are connected parallel to the n SPS inputs 9. With this circuit arrangement, it is assured that an actuation of the pushbuttons T1 through Tn trips an edge signal in the first PC control unit for function assignment 3 and in the control unit for flag assignment 4 of the SPS.

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In the internal organization of the intrinsically conventional operating means in the PC, within the scope of the embodiment of the SPS of the invention shown in Fig. 1, a central memory unit 1 is provided, in which, for each selectable key level, a data matrix to be described in further detail hereinafter is stored in memory, in
5   which matrix, each of the n pushbuttons is assigned one data line that contains information that is allocated in columns to different purposes.

In detail, in Fig. 1, by way of user inputs, optionally dependent on the status of the machine 11, a user control region with an associated key level is selected.
10 This key level is an input parameter for the central control element for level control 2. The level control 2 acts as a data shunt between the central memory unit 1 and the data-processing control units for function assignment 3, flag assignment 4 and key display 6:

15   The control unit for key display 6 receives the labeling information. It is responsible for the screen outputs. The control unit for function assignment 3 receives the information on PC function identification. It links the pushbutton signal with the PC function identification to make a starting signal for the corresponding surface function 5. The control unit for flag assignment 4 receives
20 the information on SPS function flags and SPS feedback flags via the data interface 8. It links the pushbutton signal with the SPS function flag, which is then processed via the SPS user logic 7 into an output signal to the machine 11. As a second function, the flag assignment 4 sends the state of the SPS feedback flag to the PC control unit for key display 6 via the data interface 8.
25
For further explanation of the mode of operation of the embodiment shown in Fig. 1, the signal paths for tripping a surface function or machine function will be described below.

30   Signal path on tripping a surface function:

Actuate pushbuttons T1 through Tn -> trip edge signal in control unit for function assignment 3 via the ISA bus 14 -> linkage with PC function ID -> start of the surface function 5 -> send signal "function ON" to key display 6 -> display of

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"function ON" on the screen 12.

Release pushbuttons T1 through Tn -> surface function 5 remains active, until terminated by user or by some other function 5.

5

Signal path on tripping a machine function:

Actuate pushbuttons T1 through Tn -> via SPS input, trip edge signal in control unit for flag assignment 4 -> setting of the SPS function flag -> user logic 7
10 links the flag to other SPS information -> setting of the associated SPS output 10 (start machine function) once all conditions have been met -> setting of the SPS feedback flag -> trip edge signal in control unit for flag assignment 4 -> send flag status via data interface 8 to control unit for key display 6 -> display of "function ON" on the screen 12.

15

Release pushbuttons T1 through Tn -> via SPS input 9, trip edge signal in control unit for flag assignment 4 -> resetting of SPS function flag -> user logic 7 links the flag to other SPS information -> resetting of the associated SPS output 10 (stop machine function), if no self-holding -> resetting of the SPS feedback flag
20 -> trip edge signal in control unit for flag assignment 4 -> send flag status to key display 6 via data interface 8 -> display of "function OFF" on the screen.

In Fig. 2, as an example, a user surface of the SPS of the invention is shown, in the form of a monitor 16 with a screen 12 and additional pushbuttons T1
25 through Tn. The keys shown are embodied as pushbuttons. They should advantageously be located in the immediate vicinity of the screen 12 in such a way that the user can establish a direct relationship with the label and status information on the screen 12. The key label 17 is done in reserved areas of the screen 12. The status information can be displayed for instance by way of
30 changing the color of the key label 17. A defined number of pushbuttons T1 through Tn is combined into one group of keys. The meaning of the keys always changes for the entire group of keys and can be summarized in an abstract key level.

In a central memory unit 1 of the PC, shown symbolically in Fig. 3, the data base of the key allocation is stored in memory. From 1 to n pushbuttons are assigned the following information in a two-dimensional data matrix 15:

5   - SPS function flag
- is connected to the corresponding SPS input 9
  and represents a 1:1 image of the key status.
  This column of the data matrix 15 is
  compulsory for all the embodiments with a

10   data matrix 15.
- SPS feedback flag
- is set by the SPS user logic 7, when the
  machine function is active.
- PC function ID

15   - Function identification of the surface
  function 5, such as error report, which is
  started upon actuation of the pushbutton.
- Labeling

20   For each key level, one data matrix 15 is stored in the central memory unit 1, as indicated in Fig. 3 for three key levels, as an example.

The various items of information in the data matrix 15 are carried onward, as indicated by the arrows in Fig. 3, to various data-processing control units 3, 4 and

25   6 (which for instance are the same for information that is intended to belong together).

List of Reference Numerals

	1	PC memory unit
5	2	PC control element for level control
	3	PC control unit for function assignment
	4	PC control unit for flag assignment
	5	PC surface functions
	6	PC control unit key display
10	7	SPS application logic
	8	Data interface
	9	SPS input
	10	SPS output
	11	Machine
15	12	PC screen
	13	PC keyboard
	14	PC bus
	15	Data matrix in 1
	16	PC monitor
20	17	Key label on PC screen 12
	T1-Tn	Pushbuttons